

A MONETARIST MODEL OF EXCHANGE RATE DETERMINATION

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Almost four years have passed since the major nations of the world decided to let their currencies float, jointly or individually. During this period foreign exchange rates have exhibited sharp movements, examples being the recent precipitous fall of the international value of the British pound, the Italian lira, and the Mexican peso as well as sharp gyrations in the U. S. dollar relative to the German deutschmark.

Among the explanations that have been advanced to account for these movements is the monetarist approach, which views national monetary policies as the primary factor directly or indirectly influencing exchange rates. As usually presented, the monetarist approach emphasizes that the exchange rate is determined by demands for and supplies of national currencies; that it is subject to the same influences as other asset prices (e.g., stock prices); that it is particularly sensitive to expectations about future exchange rates, expectations that are heavily conditioned by recent and current monetary policies; and finally that it reflects all available information about the two currencies and therefore alters in response to new information about changed circumstances. In accord with this view, monetarists argue that one reason for the observed volatility of exchange rates is that monetary policies of major nations have been variable and erratic. Policy changes, so the argument goes, have induced asset holders to alter their expectations of future exchange rates, thereby resulting in large movements in current exchange rates. A second factor allegedly contributing to exchange rate movements is lack of policy coordination among nations as manifested by divergent rates of monetary growth. Monetarists contend that this factor produces international differential inflation rates that are a primary source of exchange rate variability. It follows, therefore, that the way to achieve exchange rate stability is for countries to abandon monetary fine-tuning for policy rules calling for uniform constant rates of monetary growth per unit of trend output.

If the foregoing monetarist view sounds familiar, it is probably because it appears so frequently in the financial journals and the popular press. For example, Milton Friedman regularly espouses it in his *Newsweek* column, as do the editors of the *Wall Street Journal* and analysts writing in Citibank's *Monthly Economic Letter*.¹ Rarely, however, do these commentators mention the analytical framework underlying their analysis, although that framework is a standard part of the monetarist approach.¹

The purpose of this article is to present one version of this framework and to discuss its public policy implications. The framework is represented in the form of a simple two-country, seven-equation expository model of exchange rate determination.² This model has a long history dating back at least 175 years. A rudimentary version of it was first used by David Ricardo, John Wheatley, and other classical economists to explain the fall of the paper pound following Britain's suspension of convertibility of notes into bullion at a fixed price during the Napoleonic wars. Later it was employed by the Swedish economist Gustav Cassel to explain the fall of the German mark during World War I and afterward in the famous hyperinflation episode of the early 1920's. In fact, the model in one form or another has been at the center of monetarist policy discussion and analysis whenever flexible exchange rates have been in operation.³ Applied to recent experience, the model is capable of explaining why exchange rates have been so volatile and why expectational influences have caused them to deviate from levels suggested by underlying rates of monetary and income growth alone.

¹ This framework has been thoroughly developed in the scholarly, if not the popular, literature. See in particular the papers cited in the list of references at the end of this article. The present article draws heavily from these sources.

² The model presented here is adapted from similar models developed by Bilson [1, 2], Dornbusch [3], Frenkel [4], Fry [5], Magee [6], and Mussa [7].

³ See Frenkel [4] and Myhrman [8], especially the latter, for a discussion of the role of the monetarist approach in earlier exchange rate debates.

Key Propositions Central to the model are six ingredients that should be acknowledged at the outset. These include (1) the quantity theory of money, (2) the purchasing power parity doctrine, (3) the interest rate parity concept, (4) the Fisher relationship (named for the economist who first formulated it) between nominal and real interest rates, (5) a monetarist expectations-formation hypothesis, and (6) the efficient markets hypothesis. The quantity theory states that the price level clears the market for money balances by bringing the real (price-deflated) value of the nominal money stock into equality with the real demand for it. The purchasing power parity doctrine states that the equilibrium exchange rate is such that a unit of a given currency commands the same quantity of goods and services abroad when converted into the other currency as it commands at home. This implies that the buying powers of the two currencies are the same when expressed in terms of a common unit at the equilibrium rate of exchange. Such purchasing power equalization eliminates profitable opportunities for commodity arbitrage, thereby insuring that existing stocks of national currencies will be willingly held and that the markets for real cash balances in both countries will clear simultaneously. Similar reasoning underlies the interest rate parity concept, which states that the real rate of return on capital assets tends to be everywhere the same and independent of the currency denomination of the asset. The Fisher relationship states that the nominal rate of interest equals the real rate of interest plus the expected rate of inflation. Taken together, the Fisher relationship and the real interest rate parity concept imply that international nominal interest rate differentials reflect differences in national inflationary prospects. The monetarist expectations-formation hypothesis states that the public forms expectations of the future rate of inflation on the basis of its perception of the likely future course of monetary policy. Finally, the efficient markets hypothesis states that the current market price of an asset (e.g., foreign exchange) reflects all available information and adjusts instantaneously to incorporate new information. Constituting the central analytical core of the monetarist view of exchange rate determination, the foregoing propositions are incorporated into the model presented below.

The Model and Its Components The model itself consists of seven equations containing the following variables. Let M be the nominal money stock (assumed to be exogenously determined by the central bank) and m and m^e be the current and expected

future rates of growth of that stock. Furthermore, let D be the real demand for money, i.e., the stock of real (price-deflated) cash balances that the public desires to hold, Y the exogenously determined level of real income, i and r the nominal and real rates of interest, respectively, and $-a$ the interest elasticity of demand for money. Also let X be the exchange rate (defined as the domestic currency price of a unit of foreign currency), P be the price level, E be the expected future rate of inflation, and I be the set of information upon which those expectations are based. Asterisks are used to distinguish foreign-country variables from home-country variables, and the subscript w refers to the entire world economy.

The foregoing variables are linked together via the following relationships:

- (1) $P = M/D$ and $P^* = M^*/D^*$
- (2) $D = Y i^{-a}$ and $D^* = Y^* i^{*-a}$
- (3) $P = X P^*$
- (4) $i = r + E$ and $i^* = r^* + E^*$
- (5) $r = r^* = r_w$
- (6) $E = E(m^e)$ and $E^* = E^*(m^{e*})$
- (7) $m^e = m^e(m, I)$ and $m^{e*} = m^{e*}(m^*, I^*)$

The first relationship, which can also be written as $M/P = D$, is the monetary equilibrium equation. It states that the price level in each country adjusts instantaneously to bring the real value of the nominal money stock into equality with the real demand for it thereby clearing the market for real cash balances. Note that the equation also implies that, given the real demand for money, the price level is determined by and varies equi-proportionally with the nominal money supply. This latter result, of course, is the essence of the quantity theory of money.

The second equation is the money demand function that expresses the public's demand for real cash balances as the product of two variables, namely real income and the nominal interest rate. The former variable is a proxy for the volume of real transactions effected with the aid of money and thus represents the transactions demand for money. By contrast, the interest rate variable measures the opportunity cost of holding money. The parameter $-a$, which appears as the exponent on the interest rate variable, is the interest elasticity of demand for money. This parameter measures the sensitivity or responsiveness of money demand to changes in the interest rate and is assumed to be a negative number indicating that desired real cash balances vary inversely with the cost of holding them. Note that the numerical magni-

tude of the interest elasticity coefficient is assumed to be the same in both countries. Note also that the income elasticity of demand for money, as represented by the exponential power to which the income variable is raised, is assumed to possess a numerical value of unity.

The third equation of the model is the purchasing power parity relationship showing how national price levels are linked together via the exchange rate. As indicated by the equation, prices in both countries are identical when converted into a common unit at the rate of exchange. This means that the exchange rate equalizes such (normalized) price levels and, by implication, the purchasing power of both moneys expressed in terms of a common currency unit. This condition of equalized purchasing power is of course necessary if the two national money stocks are to be willingly held and equilibrium is to prevail in both money markets simultaneously. If the purchasing powers were unequal, people would demand more of the high- and less of the low-purchasing power currency on the market for foreign exchange. The resulting excess demand for the former and the corresponding excess supply of the latter would cause the exchange rate between the two currencies to adjust until purchasing power was equalized and both money stocks were willingly held. Note also that the purchasing power parity equation can be rearranged to read $X = P/P^*$, thus corresponding to the monetarist interpretation of the exchange rate as the relative price of two currencies, i.e., as the ratio of the foreign currency's value in terms of goods to the domestic currency's value in terms of goods. Since the value of a unit of currency in terms of a composite market basket of commodities is the inverse of the general price level $1/P$, it follows that the relative price of the two moneys is simply the ratio of the national price levels as indicated by the equation.

The fourth and fifth equations explain the determination of the nominal and real rates of interest, respectively. Following Irving Fisher, the fourth equation defines the nominal interest rate as the sum of the real rate of interest and the expected future rate of inflation, the latter variable being the premium added to real yields to prevent their erosion by inflation. The fifth equation expresses the concept of interest rate parity according to which real yields on assets tend to be the same everywhere and independent of the currencies in which denominated. Since capital is mobile internationally, i.e., foreigners can purchase domestic securities and domestic citizens can purchase foreign securities, it follows that

real yield equalization is necessary if all asset stocks are to be willingly held. Accordingly, the equation states that real interest rates in both countries are the same and are equal to a given constant world rate. Taken together, equations 4 and 5 imply that international nominal interest rate differentials reflect differences in expected future national rates of inflation. For example, if the market expects the future rate of inflation to be 10 percent in the U. K. and 3 percent in the U. S., then the U. K. nominal interest rate will be 7 percentage points above the corresponding U. S. interest rate.

The sixth and seventh equations together explain how the public forms its expectations of the future rate of inflation. These inflationary expectations constitute the anticipated future rates of depreciation of money holdings. As such, they enter the foreign and domestic demand for money functions via the nominal interest rate variables and thereby play an important role in determining the exchange rate. Regarding the formation of price anticipations, equation 6 expresses the monetarist hypothesis that inflationary expectations are based on what the market believes the future rate of monetary growth will be. This of course means that the market must forecast the future rate of monetary growth in order to forecast the future rate of inflation. Equation 7 explains how money growth forecasts are formulated. The equation embodies the assumption that people formulate expectations rationally, using all available information in predicting future monetary growth, and perhaps revising their predictions as new information appears. Relevant information includes recent policy pronouncements, imminent political changes, data on past and current behavior of the monetary aggregates, past observations on the policymakers' responses to changes in the economy, and the like. In equation 7, the information input is represented by two variables, namely the current growth rate m of the monetary aggregates and all other information I . The model does not attempt to explain precisely how money growth forecasts are derived from this information. It simply assumes that the forecasts are somehow made, that they constitute the most accurate predictions possible given the state of the market's knowledge and the availability of information, and that they form the basis for future price anticipations. Note that the substitution of equation 7 into equation 6 yields the efficient market hypothesis that the price expectations underlying the exchange rate reflect all available information concerning it.

Linkages and Causation Taken together, the foregoing relationships constitute a simple seven-

equation system that embodies the monetarist view of exchange rate determination. The equations imply two unidirectional channels of influence—one direct, the other indirect—running from money to prices to the exchange rate. Regarding the former channel, the model implies that the actual stock of money affects prices and the exchange rate directly through the monetary equilibrium and purchasing power parity equations. As for the indirect channel, the model implies that the anticipated future growth rate of money influences prices and the exchange rate indirectly through the price expectations component of the nominal interest rate variable that enters the demand for money functions. More specifically, the model postulates the following causal chain:

1. Current and past monetary growth rates influence predictions of future monetary growth.
2. Predictions of future monetary growth determine the expected rate of inflation.
3. Given the real rate of interest, inflationary expectations determine the nominal rate of interest.
4. The latter variable, together with the given level of real income, determines the demand for money.
5. Given the demand for money, the nominal money stock determines the price level.
6. Finally, the two price levels, foreign and domestic, together determine the exchange rate.

Clearly, in the model presented above, the linkages run from money (actual and anticipated) to prices to the exchange rate. Moreover, all variables affecting the exchange rate do so through monetary channels, i.e., through the demand for or supply of money. In this sense, money demand and supply may be said to constitute the *proximate* determinants of the exchange rate. The *ultimate* determinants, however, are the variables that underlie and determine the monetary factors themselves, namely income, interest rates, price expectations, money stocks and their growth rates, and other exogenous information.

Determinants of the Exchange Rate To show the relationship between the exchange rate and its ultimate determinants, simply substitute equations 2-7 into equation 1 and solve for the exchange rate. The resulting "reduced form" expression is

$$(8) \quad X = [M/M^*][Y^*/Y][i/i^*]^a$$

or, since the nominal interest rate i is the sum of the real interest rate r and the expected rate of inflation E ,

$$(8') \quad X = \left[\frac{M}{M^*} \right] \left[\frac{Y^*}{Y} \right] \left[\frac{r + E(m, I)}{r^* + E^*(m^*, I^*)} \right]^a$$

Equation 8 (or 8') collects the determinants of the exchange rate into three groups, namely relative money supplies, relative real incomes, and relative nominal interest rates comprised of a fixed real rate component and a variable price expectations component. Of these three groups, the first captures purely monetary influences on the exchange rate while the second and third capture real and expectational influences, respectively.

Regarding the first group of determinants, the equation implies that, all else being equal, the country with the faster monetary growth will find its currency depreciating on the foreign exchanges. As for the second group of determinants, the equation predicts that, everything else being equal, the country with the faster growth of real income and hence real demand for money will experience an appreciating exchange rate. The reason is straightforward. Given a constant nominal money stock, a real income-induced rise in the demand for it necessitates a fall in the price level to clear the market for money balances. Since the required price fall is greater in the high-growth economy, and since the exchange rate by definition is the ratio of the two price levels, it follows that the high-growth country's currency will be appreciating on the foreign exchanges. Note that the monetarist conclusion that real income growth tends to appreciate (lower) the exchange rate contradicts the traditional trade balance view that income growth depreciates the exchange rate by inducing a rise in the home demand for imports.

Finally, as regards the third group of determinants, equation 8 (or 8') states that, everything else being equal, the country with the relatively worsening inflationary prospects will have a depreciating exchange rate. There are two explanations for this. First, people will desire to hold relatively less of the currency whose value is expected to fall the most. Therefore the relative asset demand for that currency will fall and the exchange rate will depreciate—assuming, of course, that no compensating changes occur in relative money supplies. Second, contracts will tend to be written in terms of the currency that is expected to depreciate the least, i.e., the stronger currency will be preferred to the weaker as an international unit of account, standard of value, and medium of exchange. The resulting fall in the relative transactions demand for the weaker currency will reduce its value on the foreign exchanges. In short, an anticipated depreciation of a currency will reduce both the asset and transactions demand for it thereby helping to bring about the very depreciation that is anticipated. Note, however, that such anticipations

are not independent of recent and current monetary policies (represented by the variables m and m^* in equation 8') but are strongly conditioned by them. Within the context of the model, at least, a history of unrestrained monetary expansion will produce expectations of more of the same thereby contributing to the weakness of the currency on the foreign exchanges. Similarly, a history of monetary stability will help create the favorable expectations that contribute to a currency's strength.

The preceding discussion gives some indication of the importance that monetarists attach to the role of expectations in determining exchange rates. Corresponding to this emphasis on expectations, equation 8' specifies divergent inflationary prospects as the reason why exchange rates often deviate from levels suggested by relative money stocks and real incomes alone. According to the equation, the exchange rate will conform to the level suggested by the underlying fundamentals only when inflationary expectations are the same in both countries. In this special case, expected future rates of return on both currency holdings are identical and cancel out, and the exchange rate is determined solely by the fundamentals. In all other cases, however, differential expected inflation rates influence the exchange rate and cause it to diverge from the level predicted by the fundamentals, i.e., relative money stocks and real incomes.

Equation 8' would be of little interest to analysts and policymakers were it incapable of explaining another characteristic of recent floating rate experience, namely exchange rate volatility. Fortunately, however, the equation can account for such behavior and does so by identifying two main sources of exchange rate movements. The first is shifts in relative money supplies (M/M^*) owing to monetary policies that are variable and divergent as between countries. For example, oscillatory movements in the exchange rate could be produced by two countries engaging in discretionary countercyclical monetary policy but always in opposite directions, A's money stock expanding when B's contracts, and vice versa.

The second source of exchange rate volatility identified by equation 8' is expectational shifts occasioned by the appearance of new information—e.g., announced changes in policy targets—about the future prospects for various currencies. The new information leads the market to revise its opinion about the future costs and returns from holding the different currencies. Reflecting these expectational shifts, exchange rates change until the existing stocks of the various currencies are again willingly held. Note that exchange rates are no different than stock prices in this respect. Just as the price of a firm's stock at

any moment reflects all available information about the future profitability of the firm, so also does an exchange rate embody all known information about the future values of two currencies. New information that alters the market's perception of these future values will result in sudden changes in exchange rates just as new information about future firm profitability causes sharp shifts in a stock's price. Both are special cases of the general rule that, given new information about changed circumstances, the market price of any asset—whether equity share or unit of foreign currency or whatever—must change until the outstanding stock of the asset is willingly held.

A third possible source of exchange rate instability is variations in the ratio of real incomes (Y^*/Y). This factor, however, is deemphasized by monetarists who believe it to be dominated by shifts in relative money stocks and relative inflationary expectations.

Policy Implications of the Model This article has presented a monetarist model that specifies money stocks and inflationary expectations as key determinants of the exchange rate and that stresses the role of monetary policy in influencing these determinants. Specifically, the model postulates that money stocks are exogenously controlled by national central banks and that the public's expectations about the future purchasing power of various currencies are strongly shaped by current policy actions and announcements. Several implications follow from the model. It is well to remember, however, that these implications reflect the particular assumptions underlying the model and that some of these assumptions are disputable. This is especially true of the assumptions of purchasing power parity, real interest rate parity, and exogeneity of real income. While these conditions may hold in long-run equilibrium, empirical evidence suggests that they may not hold over any realistic short-run policy horizon nor over the transitional adjustment period following economic shocks. Recognition of this fact would probably modify any policy prescriptions based on the model. Subject to these caveats, the policy implications of the model are summarized below.

The first implication is that, given the rate of foreign monetary growth, the most effective means of halting and reversing a depreciation of the exchange rate is a preannounced permanent reduction in the rate of domestic monetary expansion. As new information, the announcement itself will of course have an immediate impact on the exchange rate through the price expectations channel. For this impact to be anything more than temporary, however,

the public must be convinced that the announced policy target is a reliable indicator of the future growth rate of the money stock. To convince the public of this, the authorities must bring the actual rate of monetary growth into conformity with the announced target rate since the public forms its expectations of future monetary growth at least partly on the basis of the observed current growth rate. Assuming this is done and the stable money growth rate target is thereafter permanently adhered to, the exchange rate will continue to be strengthened through the money stock and price anticipation channels.

A second policy implication is that exchange rate movements are going to occur when domestic monetary policies are divergent and inconsistent as between countries. This can be demonstrated by rewriting equation 8 as $X = (M/Y)(Y^*/M^*)(i/i^*)^a$. As written, this expression shows the relationship between the exchange rate, its underlying national money/output ratios, and of course the interest rate ratio. Dissimilar monetary policies (i.e., international differences in rates of monetary growth per unit of real output) cause the money/output ratios to diverge. When this happens relative inflationary expectations are also affected, thereby producing changes in the interest rate ratio. These changes augment and reinforce the impact of the divergent money/output ratios on the exchange rate. Because of these influences, the exchange rate is going to vary when monetary policies differ as between countries.

The exchange rate will be stable only if both countries agree to keep their money/output ratios constant or at least growing at the same rate. This in turn requires that both countries abandon divergent policies for a uniform rule tying the money growth rate to the growth rate of real income. Note in particular that within the context of the model it is impossible for a single country to stabilize the exchange rate by adhering to a monetary rule if the other country persists in monetary fine-tuning. In short, exchange rate stability is virtually impossible when countries pursue incompatible monetary policies.

A third policy implication, therefore, is that policy coordination or harmonization is the key to exchange rate stability. If two countries agree to adopt the same monetary expansion rule—e.g., a rule calling for a constant rate of domestic monetary growth fixed in relation to the trend growth rate of domestic output—then both will enjoy the same long-run stable domestic inflation rate, and the floating exchange rate between their currencies will be virtually as constant as an institutionally fixed rate. In this

case, policy coordination would allow the countries to enjoy the advantages of a fixed exchange rate while retaining some degree of national monetary autonomy.

The preceding discussion raises several questions. Why is exchange rate constancy so important? Is the type of exchange rate regime *per se* crucial to the attainment of that objective? Regarding the first question, it can be stated unequivocally that exchange rate constancy is a prerequisite for an efficiently operating international monetary system. This is because money, in its role as a social device for economizing on the use of scarce resources in the generation and transmission of economic information, is most effective when its value across countries is stable, certain, and predictable. These qualities of course are lacking when exchange rates fluctuate and money therefore functions poorly as a resource-economizer. In such situations, traders themselves must forecast shifts in the value of currencies, bear the risks of such shifts, or hire someone else to bear the risks. Either way, real resources—effort, time, knowledge—are diverted from productive pursuits into forecasting and risk-taking activities that would be totally unnecessary if exchange rates were constant. It follows that the international economic system is not going to be operating at peak efficiency as long as exchange rates continue to fluctuate. On efficiency grounds alone, therefore, exchange rate constancy is a desirable objective.

As for the question of whether a specific exchange rate regime—fixed or floating—is crucial to the attainment of that objective, the answer appears to be in the negative. The preceding analysis suggests that the key to achieving exchange rate constancy lies less in the way the foreign exchange market is organized than in finding a means of coordinating national monetary policies. As previously mentioned, policy coordination in the form of the adoption of uniform rules is required if exchange rates are going to be constant in a floating rate regime. Similarly, some sort of coordination is necessary in a fixed rate regime, otherwise countries might inflate their domestic money stocks at different rates forcing a breakdown of the system. To summarize, policy coordination, not the exchange rate regime, is the *sine qua non* for exchange rate stability.

Summary This article has presented a simple expository model of exchange rate determination that incorporates key elements of the monetarist approach. These elements lead to the conclusion that the exchange rate is determined by relative money stocks, relative real incomes, and relative inflationary expect-

tations, with the last variable being strongly conditioned by observed rates of monetary growth. The model is helpful in explaining exchange rate volatility and the tendency for some currencies to remain over-

or under-valued for long periods. Finally, the model provides a useful framework for specifying the conditions necessary for the attainment of exchange rate stability.

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